The First Practical Solar Power Satellite via Arbitrarily Large PHased Array (SPS-ALPHA)

Completed Technology Project (2011 - 2012)

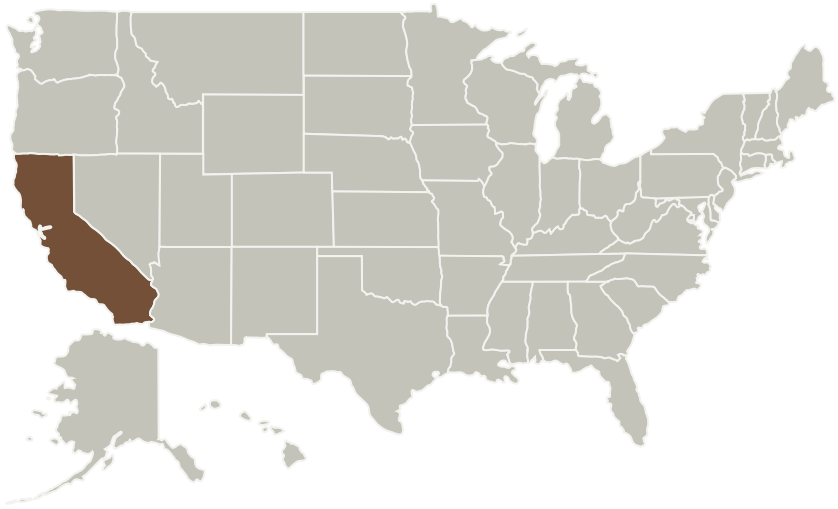
Project Introduction

SPS-ALPHA (Solar Power Satellite via Arbitrarily Large Phased Array) is a novel, bio-mimetic approach to the challenge of space solar power. If successful, this project will make possible the construction of huge platforms from tens of thousands of small elements that can deliver remotely and affordably 10s to 1,000s of megawatts using wireless power transmission to markets on Earth and missions in space. The selected NIAC project will enlist the support of a world-class international team to determine the conceptual feasiblity of the SPS-ALPHA by means of integrated systems analyses, supported by selected "proof-of-concept" technology experiments.

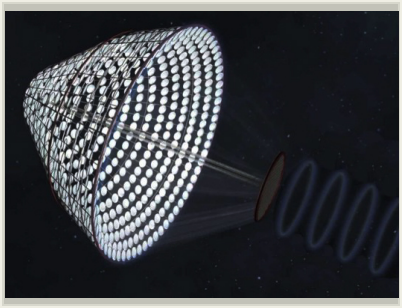
Anticipated Benefits

This technology application can be useful for supporting missions in a number of areas including human or robotic space exploration missions, civil, commercial, and military space missions, energy for terrestrial markets, and NASA spinoffs.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Artemis Innovation Management Solutions	Lead Organization	Industry	Santa Maria, California



Project Image SPS-ALPHA: The First Practical Solar Power Satellite via Arbitrarily Large PHased Array

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Primary U.S. Work Locations
California

Project Transitions

September 2011: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Artemis Innovation Management Solutions

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

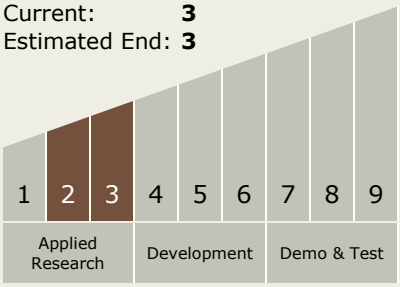
Eric A Eberly

Principal Investigator:

John C Mankins

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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September 2012: Closed out

Closeout Summary: The SPS-ALPHA concept represents a very different architecture for space solar power, involving a hyper-modular approach in which all platform elements can be mass produced, and none are larger than a small sat. If proven feasible, SPS-ALPHA could enable significantly lower development time and cost, much greater ease of manufacturing at lower cost, and significantly higher reliability. During the past 40 years, space solar power for Earth has remained little more than a vision. Power for space missions has remained both scarce and expensive: most satellites operate on less power than that needed to run a typical home in the U.S., many on considerably less. If SPS-ALPHA can be developed, solar power in the range of 100s MW to 100s GW could be harvested in space and delivered efficiently to markets on Earth, and to enable energy-rich operations throughout the inner solar system - transforming all aspects of government and commercial space. Systems analysis results from the 2011-2012 NIAC Phase 1 study project suggest that SPS-ALPHA may be able to achieve economic viability. Following technology maturation and systems-level demonstrations, the SPS-ALPHA concept delivered close to commercial results (e.g., less than 20\xa2 per kW-hr) with technologies currently in the laboratory, and competitive commercial energy (e.g., less than 10\xa2 per kW-hr) with selected improvements in key technologies. Solar power satellites based on SPS-ALPHA could deliver power on demand to more than 90% of Earth's population at locations across the globe. It would have a near zero carbon footprint and facilitate reaching greenhouse gas (GHG) emission reduction goals. Affordable and continuous solar energy delivered on large scale affordably from SPS to the U.S. and other markets would transform terrestrial power since no other green energy technology has similar potential to provide sustainable and dispatchable baseload power that is essentially immune to diurnal variations or to weather. SPS-ALPHA could enable a more rapid, effective and affordable response to natural disasters and calamities (e.g., the 11 March 2011 disaster in Japan). As has been found in past studies and for other SPS concepts going back to the 1970s, ETO transportation remains a critical factor in realizing economically viable SPS for terrestrial markets. In-space transportation costs are also important, but appear closely tied to ETO cost; in other words, low-cost in-space transportation (from LEO to GEO) cannot be realized without low-cost ETO transportation. In addition, there are a number of prospective civil, commercial and security related applications of the SPS-ALPHA space systems architecture. These range from power for permanently shadowed regions at the lunar poles, to near-term applications in various Earth-orbiting satellites where a large, low-cost aperture is required. In most locations across the Inner Solar System solar energy is available, sometimes continuously. This project would advance the capability to deliver power (at less than $1/kW-hour) to civil or commercial space missions in space, on the Moon, Mars, or small bodies. The availability of reliable, inexpensive and continuous power at levels of 100s kW to 10s MW or higher would forever change the character of space systems, missions, and goals. Moreover, high power large apertures would be of great value for U.S. security space missions. And, recent studies (e.g., for DOD NSSO) concluded that development of SSP systems and technologies, including SPS, would significantly benefit the security of the U.S. and its allies. Not only would space systems benefit, but benefits would also result from delivery of assured, affordable power to forward bases, military operations, markets, and allies. Finally, ancillary SSP technologies - in areas such as space transportation, space communications, in-space construction, robotics, lightweight structures, etc. - would be of immense value to a wide range of civil / commercial space missions. The roadmap for SPS-ALPHA appears quite tractable programmatically: the hyper-modular archi

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.3 Mechanical Systems
    - TX12.3.1 Deployables, Docking, and Interfaces

Target Destination

Earth

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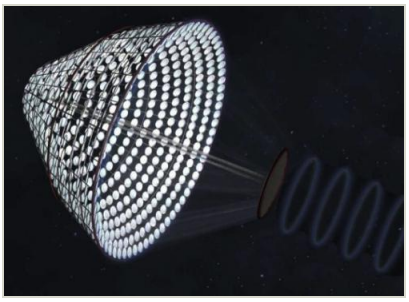
Images



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Project Image SPS-ALPHA: The First Practical Solar Power Satellite via Arbitrarily Large PHased Array
(https://techport.nasa.gov/image/102191)